TRENDS IN COAL COMBUSTION PRODUCTS (CCP) UTILIZATION IN NORTH AMERICA

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Trends in Coal Combustion Products (CCP) Use in North America

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ABSTRACT

Coal Combustion industries in North America will have to reduce emissions of Mercury and CO_2 in the next 10 to 15 years in response to public, government, and international concern over climate change. The effects of previous emission reduction technology for NO_X and SO_X, have resulted in increased levels of unburnt carbon and ammonia in the fly ash, presenting problems for use in concrete. The history of CCP use since 1999, (Table 1) has been poor availability of quality fly ash (<4%C, No Ammonia).

The American Coal Ash Association (ACAA) and the Canadian Industries Recycling Coal Ash (CIRCA) represent the CCP industry in their respective economies and both are active in promoting the increased use of CCP.

The CCP Industry is concerned how legislative changes in Air Emissions might impact the economic viability of electric power plants, Power Plant solid waste, and preserve the view that CCP is not a hazardous material. All stakeholders are concerned that the changes meet the desires of its members for the reduction of CO_2 and Mercury, and politics as always is in the middle. Potential for increased CCP replacement to offset CO_2 emission in Portland Cement production is looked at as well.

The paper reviews how regulations have contributed to trends in CCP production and changes in Engineering have increased demand and use. The strategies CIRCA and ACAA have used to increase CCP use are discussed. The paper concludes with an overview of technologies available to the CCP industry dealing with the changes new legislation will bring to CCP production, thereby maintaining current uses of CCP, increasing use in other products, and provide the potential for CO_2 credits critically needed by the electric utility plant producers of CCP, and the Portland cement industry.

Keywords: ACAA, CIRCA, cement, CO2, emissions, concrete, fly ash, greenhouse gas, and supplementary cementing materials.

Introduction: CCP Production and Use (Supply versus Demand)

The objective of the CCP industry in North America is to increase the utilization and therefore avoid of landfill. The annual production of all CCP is 7.2 M tonnes[1] in Canada (Fig. 1), and 98.2 M tonnes[2] in the US (Fig. 3). The average percentage CCP use in 2000 for Canada is 22%[1] (Table 2) and the United States is 35%[1]. ACAA and CIRCA must establish new goals to for use in 10 years. If 50 % were established, this would falls behind the experience in Europe, where data indicates 87%[3] of all CCP is used (Fig. 2).

The peak CCP utilization occurred in 1999. The impact of Low Nox Burner installation on ash quality with the doubling of unburnt carbon in fly ash, removed many ash sources from the market. High carbon ash cannot be used to replace Portland cement, as the chemicals used for entrainment are absorbed.

CCPs are a group of products including Fly ash, Bottom Ash, and Synthetic Gypsum. Fly Ash is the very light and fine material remaining after pulverized coal is burned. Perfectly round glass spheres physically describes fly ash and are key to its value. Composition comprises oxides of Aluminium, Iron, and Silica. Collection is from the boiler exhaust gases as they pass through electrostatic precipitators, and fall into hoppers.

Bottom Ash is sized similar to sand, and falls by gravity to the boiler bottom and collected either in dry or wet bottoms. This material is used as raw feed for Portland cement production. Chemically these two materials are similar. CCP comprises by volume an average of 10% of the coal fuel although this varies depending on the source of coal. There are various uses for CCP, such as fly ash replacement for Portland cement in concrete mixes, raw material in the manufacture of Portland cement, fillers for various products, engineered compacted fills in highway construction, mine backfill, flowable fills, etc.

The newest material considered a CCP, is synthetic gypsum. Since 1978 Forced oxidation (FO) as applied to wet lime / limestone flue gas desulphurisation (FGD) technology, has been employed in North America. Synthetic gypsum can replace naturally mined gypsum. Since then 20 power plants have FGD operations constituting approximately 20,000 MW[4] of scrubbed generating capacity.

Synthetic gypsum has become a very important source of material for production of Wallboard, and as a set retarder for cement mix designs. Some relevant approximate parameters are removing 1 tonne of SO_2 requires 1 tonne of lime (CaO), produces 6 tonnes of gypsum sludge with 50% solids.

Trends: The US (short) story on how Environmental rules effect fly ash

The staged implementation of Emission Reduction Legislation lead to the introduction of technologies starting with the retrofitting of older boilers, and new construction with Low Nox burners, followed by Selective Catalytic Reactors (SCR), and FGD Scrubbers. The potential for new emission reduction legislation in Mercury and CO_2, will impact CCP materials either by the technology of injecting activated carbon to scrub flue gas of mercury, or fuel switching from Coal to Natural gas. The supply of fly ash with less than

4 % residual unburnt carbon for ready mixed concrete has fallen since 1999, due in part to low Nox burner installation.

In the US, the Senate Environment and Public Works Committee, and the Bush administration have drafted legislation. The EPA is expected to release a report in January 2002, that will give power plants more leeway in meeting air pollution standards.[5] The agency has been working on an overhaul of the Clean Air Act's new source review provisions, which require industrial facilities to install expensive pollution control technology when they replace major plant modifications that increase emissions. Industry complains that the rules are so strict it is hard to expand capacity and install technology to boost energy efficiency. The new source review requirements are felt to be so strict that they include routine maintenance.

In May of 2001, the Bush Administration directed the EPA to conduct an examination of the impact of the program on investment in new capacity for industrial electrical or refinery construction, energy efficiency and environmental protection.

"The integration of SCR as part of a multi pollutant control strategy is a necessity." Says Robert McIlvaine. "It is too costly to treat each pollutant separately". The effect of SCR on converting elemental mercury to a more soluble compound is one of the subjects closely followed by this consultant.

In an article *Clean Air Act Overhaul Schedule for Later This Month*[5], Sources familiar with the report say the revised program will allow plant owners to set an emissions threshold above which they would be required to install pollution control equipment.

Trends: The Canadian Story and Other Factors affecting Quality

In Canada, Environment Canada has proposed new air and solid waste regulations, which could present barriers to increased CCP use. EPA determinations made in a 2001 review, where CCP was considered a non-hazardous material, and said to have been demonstrated suitable for soil amendment. The Canadian Transportation of Dangerous Goods Regulation (TDGR) is to be revised and transferred from the Transportation Ministry to the Environment department. Part of the review will determine how CCP will be regulated, as a hazardous material or in a beneficial use category. Regulation overview will as a result extend from production to end use.

Similar to work done by the ACAA in lobbying the EPA over its considerations, CIRCA has been in contact with the Environment officials providing information clearly characterizing what the CCP produced in Canada are in terms of metals contained and potential for leachate. CIRCA is studying the leachate from material bonded in concrete to also demonstrate the exact level of risk this poses.

A third area of government overview is a coalition of Eastern Governors, and Atlantic Premiers, who meet each year to set bi-lateral environmental accords. In June of 2001, the agreements reached include the reduction of Mercury and CO_2, beyond levels considered at the Federal level. The concern developed in this eastern part of North America is due to prevailing eastern winds, location of industry concentrated to the west, and the resultant pollution occurring over densely populated areas, in some cases equal to the entire population of Canada.

While air emission regulations do effect the CCP produced, with higher carbon and ammonia content, there is additional pressure from Solid Waste Regulations in both economies, with increased restrictions for the landfill of CCP, and inter and intra state and provincial movements. Areas of high population make landfill very expensive, and recently one utility was recently forced to divert CCP from a local landfill to a 12 hour round trip away.

Deregulation of the electric power industry, has influenced CCP, where the shift from a central management in head offices, to the individual plants been considered profit centres. Plant managers are now responsible for daily efforts to keep plant costs down and face tipping fees up to $35 USD per tonne.

Trends: How the Mississippi figures into the CCP story

The geography of North America affects the production and regional market demands for CCP. The dividing line is the Mississippi River that runs north to south, from the Canadian border, through the United States to the Gulf of Mexico. The coals produced on the east differ from those to the west, producing CCP with different amounts of Calcium oxide (CaO). To the west, fly ash is high (20%) in CaO, while those to the east are less than 10%.

Fortune provides the eastern market with this supply of low CaO to match Alkaline aggregates. Alkaline aggregate reaction (AAR) is very much an everyday concern for the Ready Mixed Concrete industry. Cement mix designs, especially for the High Performance Concretes (HPC), demand fly ash, to prevent AAR reactions that lead to cracking of structures.

Fly ash provides many benefits for the placing of concrete, including easier pumping, flow into forms, prevention of segregation in the mix, and lower heat of hydration. The finished product has many benefits with fly ash, such as increased compressive and tensile strength, lower permeability, and prevention of the aforementioned AAR.

Public infrastructure in the east has original structures without fly ash, failing due to AAR, and chloride penetration from road salt, causing reinforcing steel rebar to rust. The result is a cracked structure and loss of strength. Canada budgeted $2.65 Billion in 2000 for infrastructure renewal.

New mix designs are without exception HPC mix designs with fly ash. The replacement of failed structures, and new mega projects, such as the Boston Central Arterial job, combined with the rapid decline in supply of quality fly ash, causes great concern for designers.

Highway road construction traditionally uses asphalt as the road bed material. The replacement of these surfaces every 3 to 5 years for every kilometre of highway, compares poorly to those with concrete solutions twice the life. Increased dependence upon heavy transport for goods and services leaves many sections failing within one year. Asphalt roads have a higher rolling resistance for heavy traffic, resulting in a 10% increase in fuel consumption, when compared to concrete construction. Less pollution, and dependence on imports of oil would be the benefit. Vehicles produce 1/3 of all GHG in North America.

Trends: Industry practices supporting increased CCP use

Homes in Canada and the US has seen increased Insulated concrete form (ICF), construction replace the traditional wood frame construction. The Portland Cement Association (PCA) reports, 40% less operating energy for ICF versus wood frame. PCA estimates ICF will have 12% of the housing construction market in Canada by 2010. GHGs reduction could result in 6.8 - 10.9 million tonnes per year.

A US Industry study[6] forecast for 2001 to 2010, indicate fly ash, will lead mineral additives growth. "Fly Ash, long used elsewhere in the world as an additive to or partial replacement for cement, is expected to continue its penetration of the US market, as contractors avail themselves of the performance benefits of fly ash use coupled with its low cost." The competing supplementary cementitious material (SCM), blast furnace slag, is "expected to register subpar growth, with value gains held down by flat pricing outlooks."

Mineral Spotlight reported in May 2000[7], that strong demand from the construction industry has seen record levels of gypsum production and consumption, and the commencement of new wallboard facilities. The Gypsum association reported that wallboard demand has risen 5% per year on average for over 10 years. In both the US and Canada in 1999, a demand boom saw US Gypsum ration wallboard to customers and issue a letter to customers explaining reasons for wallboard shortages.

In the US, seventeen (17) large wallboard plants, have been constructed or are under construction since 1998, and the majority are designed to use only synthetic gypsum. This is due to the significant cost advantage of synthetic gypsum over mined gypsum. The current consumption of synthetic gypsum is only 10% of total demand, while Japan leads the world with 65% of supply. Current production of synthetic gypsum is 6.3 M t/y (US), and 0.6 M t/y. (Canada).

In 1999, US Gypsum consumption was about 31.8 M tonnes, about 72%[8], which according to Merrill Lynch was used to produce wallboard. A further 16% is used to produce Portland cement, while other uses, including agriculture, smelting, glassmaking, account for the remaining 12%[8]. The shortfall in domestic production is made up of imports of crude gypsum. Canada provides 68%[8] of imports to the east, while Mexico provides 23% to the west, and the remainder from Spain (8%)[8].

Trends: Portland cement production and avoidance of CO_2

Approximately half of the world's 60,000 M ft^2 wallboard capacity is located in the US, according to United States Geographic Service (USGS) estimates. Demand from housing markets saw North American wallboard plants operating at 98% of capacity in 1999, as demand caught up with supply.

US production topped 29,000 M ft^2 a 7.7 % increase over 1998's 27,000 M ft^2 , while Canadian manufacturers shipped almost 30% of their production to the US, and saw a 10% increase in sales to 3.88 M ft^2 in 1999[9].

Cement production (1999) in the US was 86 M tonnes, and 12.6 M tonnes in Canada. Projections are 114 M tonnes and 18 M tonnes for each economy respectively by 2010. The increase in production from 1990 to 2012 is estimated as over 59%. Environmentalists are concerned over the impact of cement powder production of CO_2 , and its potential contribution to Green house gases (GHG).

Under Kyoto, the developed economies will have to reduce their GHG emissions to 5.2% below 1990 levels in the first commitment period of 2008 to 2012. The reduction target for the US is 7% below 1990, and Canada is 6%. If the emission reduction targets were spread evenly over all economic sectors in the Annex I economies, the cement industries in each would have to reduce their GHG emissions by the same amount as the applicable national commitment. For example, the US cement industry would have to reduce its CO_2 emission in the first budget period 2008 to 2012 to 7 % below the 1990 level. The cement industry in Canada has had a very strong average growth in production in the years 1990 to 1999. Should the growth continue Canada would be 75% above 1990 levels.[10]

Current cement production technology does not allow for reductions in CO_2 with increased production to match the reductions in emissions required to meet the targets. Australia adopted strategies to reduce its CO_2 release per tonne of cement produced by 11% since 1990, while the total cement industry in the same period reduced its footprint by 4%. There is room for increased efficiency in reducing the average fuel consumption per tonne of clinker. Supplementary cementitious materials now replace about 20% of the clinker in cement in this economy. The use of mineral additions in general purpose and blended cements is expected to double over the next few years.

Trends: Where does fly ash fit in the Portland cement CO_2 reduction strategy?

In Canada, average energy efficiency for Portland cement production is nearly optimized with only one wet plant still in operation. The cement industry has committed itself to reduce CO2 emissions per metric tonne of cement produced in 2000 by 4.5% from 1990 levels 10 . The estimated average clinker content in cement is 92% 10 . The industry has committed to increased use of SCMs in blended cement, and to support increased replacement of Portland cement in concrete. CO2 emissions per tonne of cement are estimated at .85 tonnes.

In the US, average energy efficiency and estimated CO_2 emissions are higher than Canada. The production from wet plants represents 22% of total US production in 1999.[10] Fly Ash is estimated as replacing 8% of cement in concrete, and 1% of total cement consumption are due to blended cements in 1999. The American Portland Cement Association (APCA) is in the process of setting an industry target for reducing CO_2 emissions. CO_2 emissions per tonne of cement are estimated at 1.0 tonnes.[10]

The potential Portland cement replacement levels for the US and Canada could see, choosing an arbitrary 20% replacement level, results in 17.2 and 2.6 M tonnes replacement. This would result in a fly ash utilization of 60% and 43% of current production respectively. The cement industry offset for CO_2 emission avoidance would therefore be 22% and 20% respectively. The potential for replacement lies between how much quality material can be economically transported, and the silo price for fly ash.

The stage is now set for the CCP industry to provide a quality material. A product versus a by-product, a consistent supply, without effect from fluctuating plant unburnt carbon levels is needed. The producers now have the economic incentive to avoid landfill, and they need CO_2 credits, only available with the replacement of fly ash into concrete. The cement industry needs to offset its forecasted increase in cement production with the replacement with fly ash, or other SCMs. The CCP industry needs a consistent quality fly ash in order to realize this potential. The technologies to beneficiate fly ash are available today and next year new options are promising to be commercialized.

Trends: How to remove carbon and ammonia from a finely divided material

There are several carbon and ammonia removal technologies available either in commercial or pilot stage operation. Some do both, while others do one, and not the other. Costs to install vary, operational costs are worth comparing, and some provide no waste stream, and others a ‘fuel alternative’.

Categorizing the methods or technologies for fly ash beneficiation is as follows:

1. Carbon burnout
2. Microwave carbon burnout
3. Electrostatic separation
4. Particle separation
5. Carbon fixation
6. Ammonia fixation
7. Carbon floatation

Carbon burnout (CBO) is commercialized with the Progress materials CBO plants in the US. They have successfully operated and removed carbon and ammonia with heat recovery. Dominion Ash in Canada has marketed a Microwave Carbon Burnout (MCB) technology developed and pilot tested by EMR Microwave Technology Corporation over the last two years. Commercialization is expected in Canada in late 2002.

Electrostatic separation is commercialized by STI in the US, and has successfully produced quality ash, with a carbon rich waste stream. Ammonia fixation is possible as an add on.

Particle separation has used been successful, but depends on having a consistent material size and distribution to efficiently remove the relatively coarse carbon particles. Air classification works very well if it finds the right fit. Ammonia removal is obviously a needed add on.

Carbon fixation by ISG is promising, but is limited to material meeting current maximum carbon. Carbon and ammonia fixation while possible, have not competed studies of long-term effects on concrete.

Microwave Carbon Burnout (MCB)

This process evolved from EMR technology developed for the mining industry. Carbon content is a problem in ores, such as gold, where as little as 0.5 % carbon robs the final stages of 20% of the gold available. EMR was contracted to design and build a pilot plant to demonstrate the effectiveness of microwaves to remove carbon. Carbon is a perfect microwave energy receptor (See Diagram 1).

Near the end of this successful work, EMR engineers suggested coal fly ash for development. The two materials are very similar in size distribution. Dominion was contacted to help EMR develop the MCB technology for fly ash, which was successfully done in 2000 (see Drawing 1).

Samples of fly ash from all over the world have been received and tested. Carbon contents in the fly ash ranged 2 to 27 %, has been successfully processed to a consistent product, with as little carbon present as deemed desirable. Ammonia has been received at over 2000 PPM and levels were reduced to undetectable.

In 2001 EMR and Dominion continued important environmental testing to study the disposition of metals during the MCB process, this has demonstrated all metals including mercury, remain in the ash.

Emissions are very low in NO_X, as there is no fuel source other than carbon. CO_2 emissions from the combustion at the Power Plant and from MCB operation total a very small percentage of the CO_2 offset from Portland cement replacement. The carbon is a perfect target for microwave energy, while the remaining material is invisible glass particles.

Fly ash residency time is very short (less than 10 minutes), and so the throughput of material is very fast. The MCB plant is very small (15 x 18 M^2), and economical to build and more importantly very cheap to operate. Heat recovery is easily incorporated.

MCB designs are completed for 300, 000 tonne sizes, and use a modular design. This allows increasing output 100% while the capital cost increases only 25%.

The first commercial plant is expected to break ground in Canada in 2002. It will be capable of processing 300 tonnes per day, 7 days per week, 24 hours per day. Computer control allows the operator to complete other work. Carbon levels can fluctuate over wide ranges in a short period and the system adjusts automatically. The same can be said for Ammonia removal.

Strategies for increasing the utilization of CCP

While efforts are directed to lobbying environmental agencies, the main focus of short-term strategy by the ACAA and CIRCA is to increasing the awareness for increased use of CCP. For example reaching out to new graduates from Engineering programs, communication efforts to reach sectors of the public, Industry designers and regulators, and environmental lobbyists.

CIRCA has placed a purchase order to the University of New Brunswick, for an Education Module that will be Web based, and is aimed at the senior Civil engineering materials course. Continuing education will also be able to take advantage of this course. The course module will be tested out this spring and made available to all universities for the fall of 2002.

The key messages to be sent out are that fly ash is a valuable engineering material, not a waste or by-product. It is a superior SCM in its benefits and value.

The logistics required for getting comparatively low value CCP materials to market is a significant problem area. Storage, rail rates, and trucking fuel costs are all barriers to avoiding landfill. Increasing the value of CCP before it leaves the production site, is one obvious solution to overcoming these areas.

Much of the emphasis in this paper has been for the replacement of Portland cement by fly ash. It is recognized by our industry that this traditional application will not provide the solution to complete landfill avoidance. Value added products such a Light Weight Aggregates , and Non-traditional applications will provide additional markets for the balance of CCP.

ACAA and CIRCA strongly feel that any use of CCP must be effective, economical, follow sound engineering, and be environmentally acceptable.

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CIRCA

Canadian Industries Recycling Coal Ash

Trends In Coal Combustion Products (CCP)

Use in North America

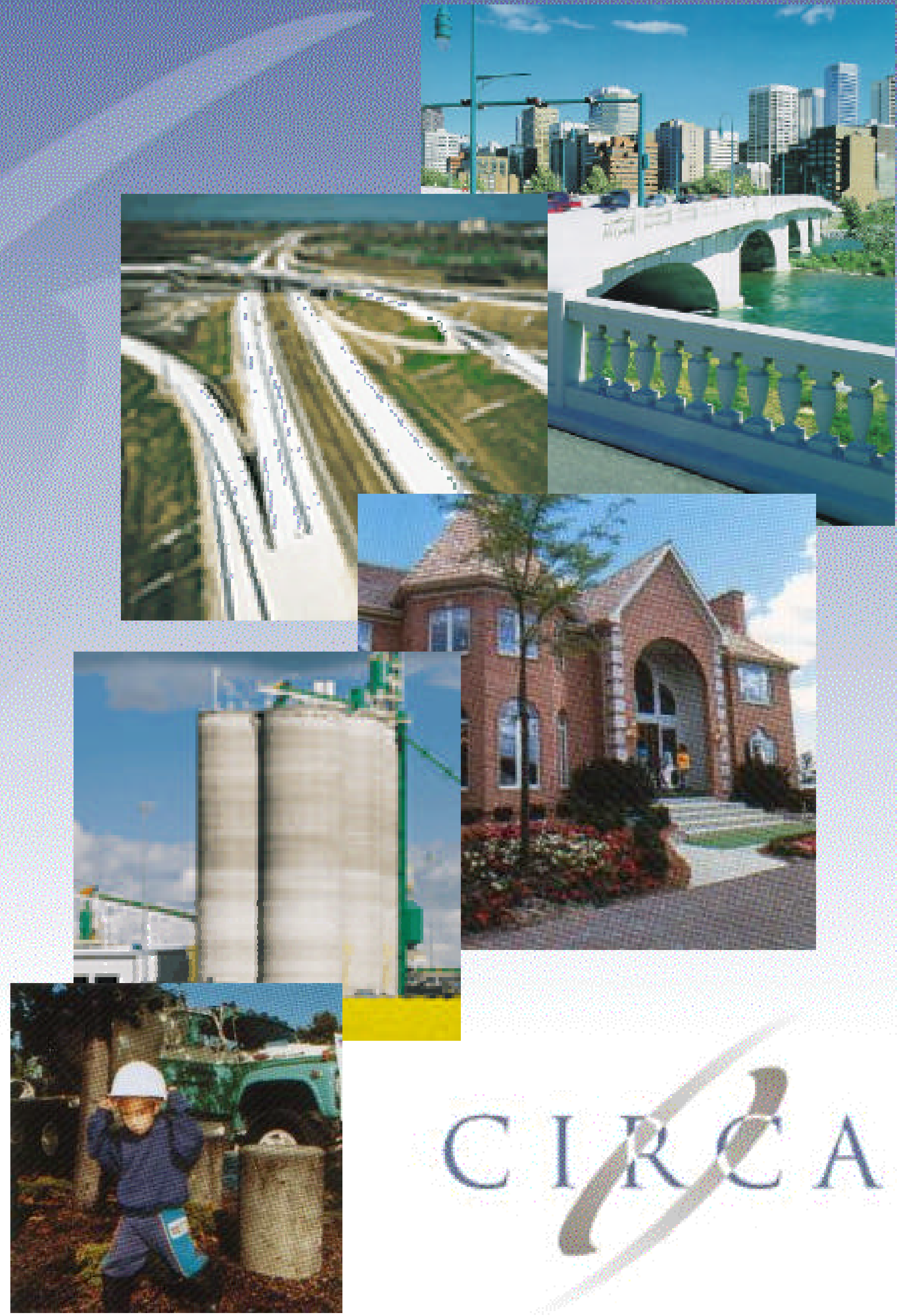
(Canada and United States)

APEC Conference
Kuala Lumpur
March 5, 2002

CIRCA

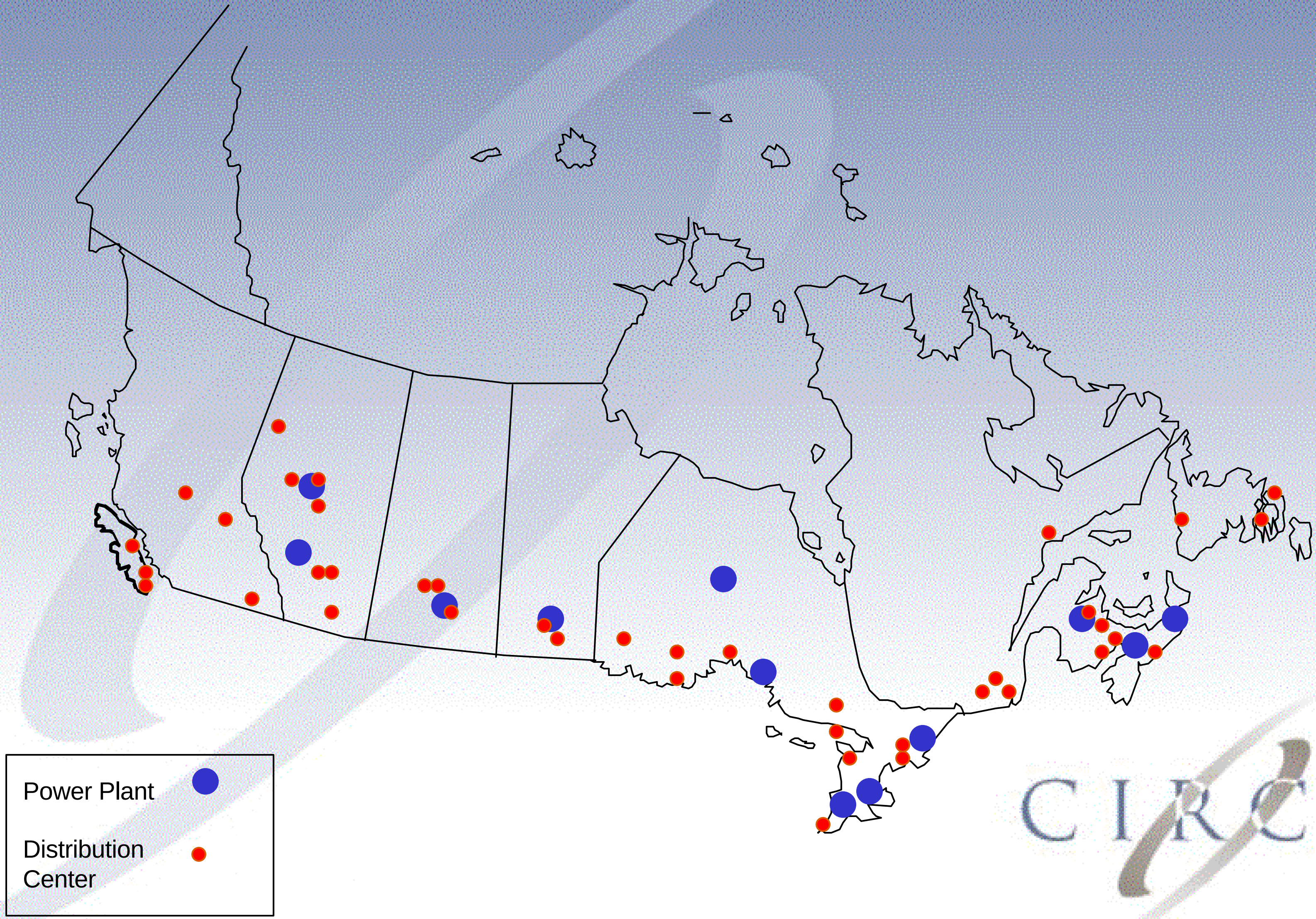
Who are we?

- Voice of Canada's coal combustion industry - represent CCP producers, and marketers
- Offices in Montreal, Toronto, Halifax, Fredericton, Calgary, Edmonton and Vancouver
- Work with strategic partners to expand the use of CCP solutions in Canada
- Provide our members with a vehicle to participate in public affairs



CIRCA

We Are Coast to Coast



CIRCA

Member Companies

CAN ASH CCP LTD
Fredericton, New Brunswick

LAFARGE CANADA INC.
Montreal, Quebec

ST. LAWRENCE CEMENT INC.
Mount Royal, Quebec

NB POWER CORPORATION
Fredericton, New Brunswick

TRANS ALTA CORPORATION
Duffield, Alberta

POZZOLANIC INTL LTD
Delta, British Colombia

NOVA SCOTIA POWER CORP
Halifax, Nova Scotia

INLAND CEMENT LIMITED
Edmonton, Alberta

ONTARIO POWER GENERATION
Toronto, Ontario

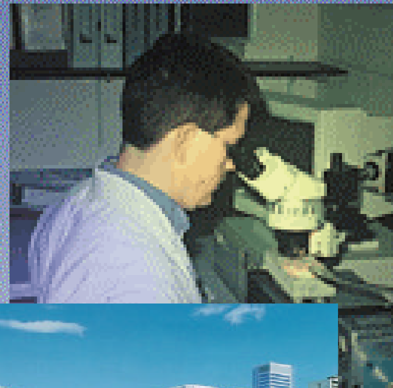
MANITOBA HYDRO
Winnipeg, Manitoba

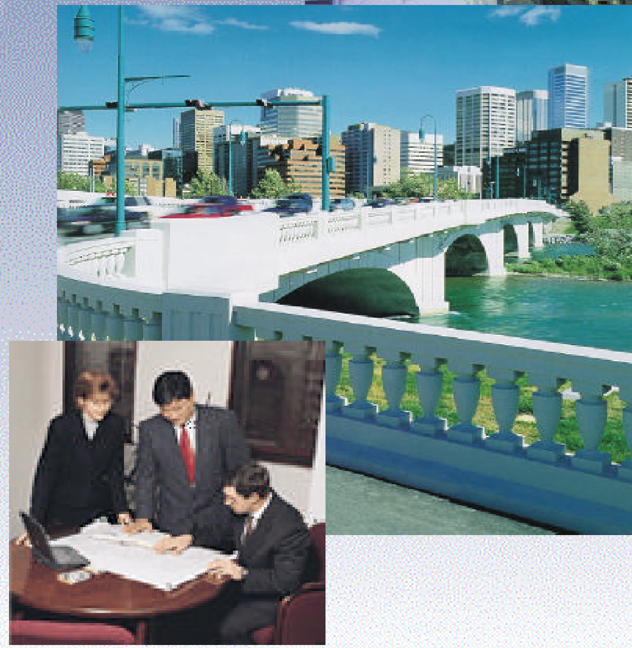
EPCOR UTILITIES INC
Edmonton, Alberta

Continuous Innovation

R&D efforts improve quality of Canadian infrastructure

- CIRCA is a leader in codes & standards, and use of CCP in HPC bridge design and construction
- CIRCA works closely with the scientific research community and strongly supports universities in R& D efforts.
- Innovations such as RCC, HPC, new concrete pavement designs, housing and waste management solutions are based on solid R&D





Coal Combustion Products (CCP)

- **CCPs are a group of Products;**
  - **Fly Ash, Bottom Ash, Slag**
  - **Synthetic Gypsum**
- **Production of High and Low CaO CCP**
  - **East Low CaO (< 10%)**
  - **West High CaO (>20%)**

Coal Combustion Products (CCP)

- Synthetic Gypsum is the newest CCP
- 1 tonne of SO_2 requires 1 tonne of lime (CaO), produces 6 tonnes of gypsum sludge with 50% solids.
- Synthetic Gypsum replaces Natural Gypsum in Wall board, and as a set retarder for cement mixes

CIRCA

Some Fly Ash Facts

- Fly Ash produces superior quality concrete and is needed in all concrete mixes. In fact, Fly Ash is necessary to make High Performance concretes.
- Cement and concrete go together like yeast and bread. Fly Ash adds to this recipe. Although it comprises only 15 to 50 % of the total cementitious content, Fly Ash contributes to increased strength, impermeability, and resistance to Alkaline Aggregate Reactive materials.

CIRCA

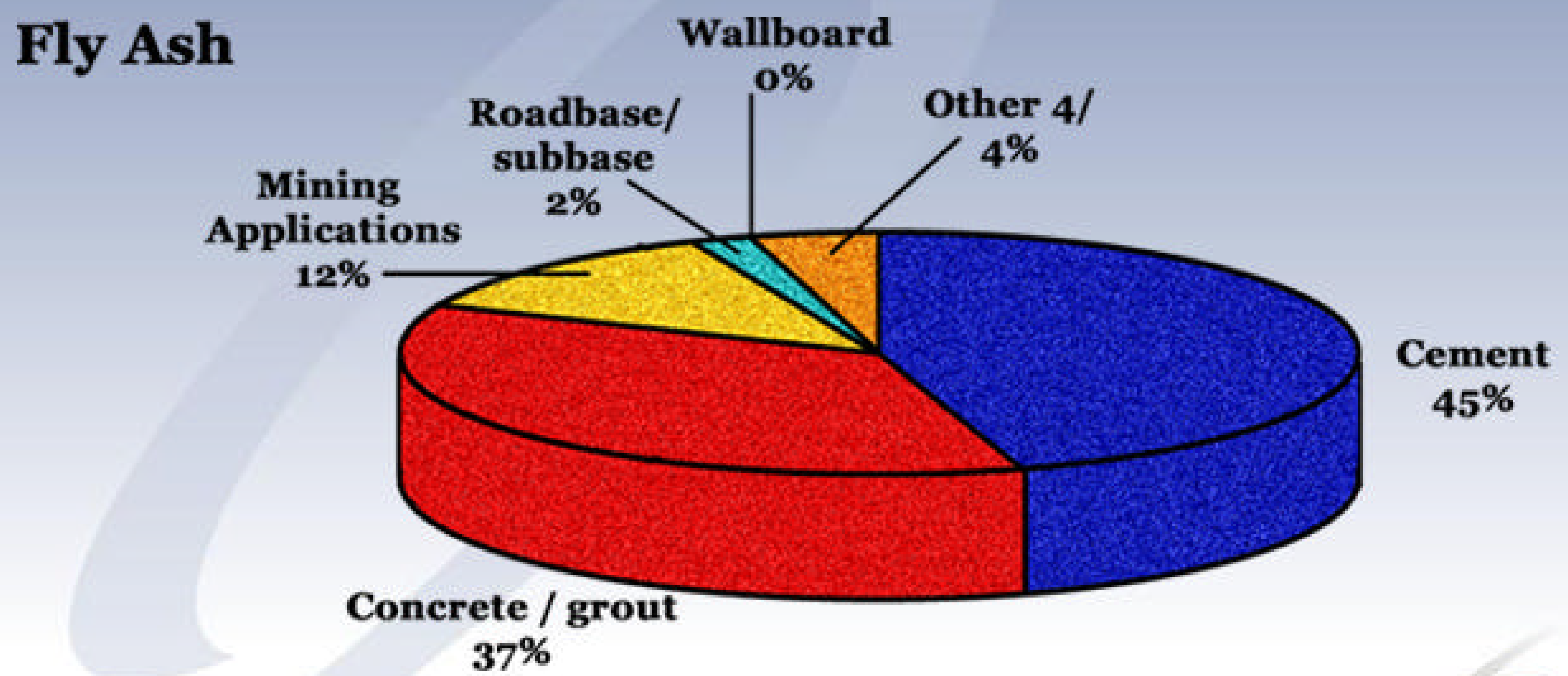
A CCP Economic and Environmental Contribution

- Use of Fly Ash in concrete increases the expected life of a structure by 100%. This saves public monies by avoiding unnecessary repair or replacement of infrastructure from coast to coast.
- Use of Fly Ash in replacing Portland Cement offsets CO2 GHG production.

CIRCA

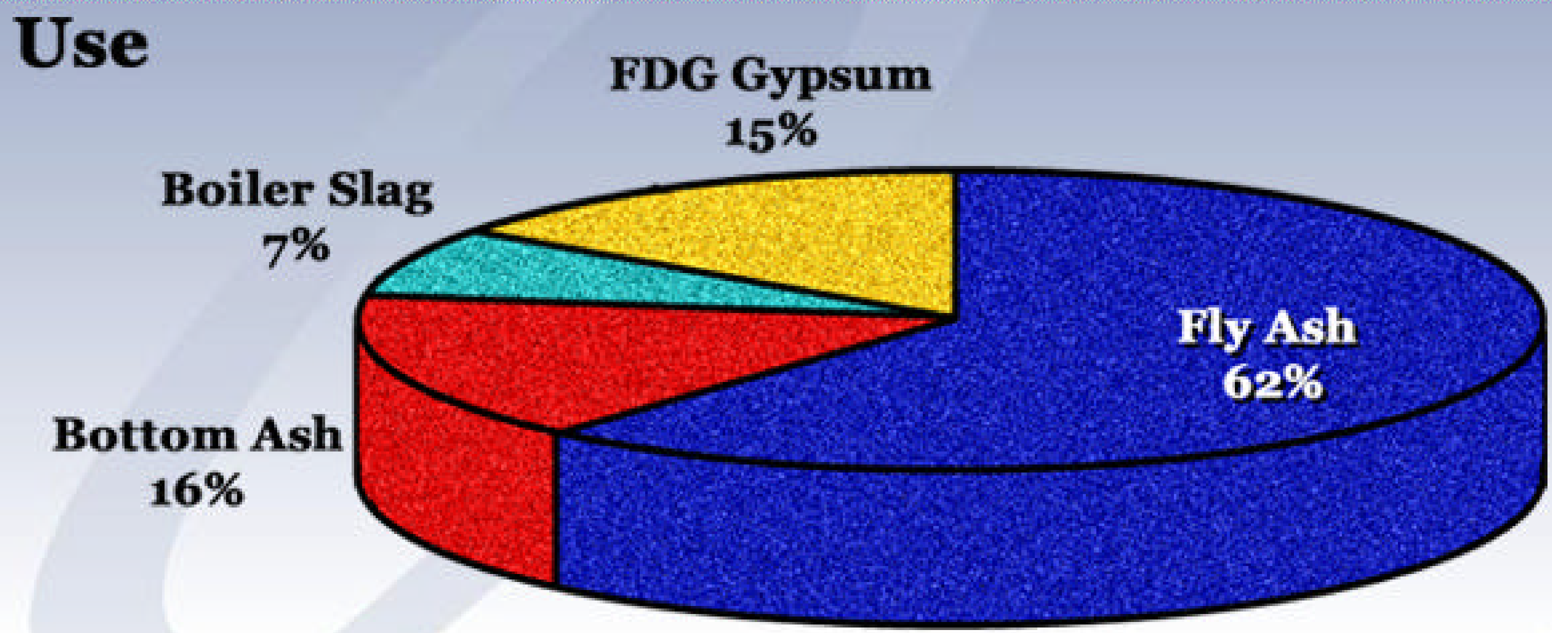
Canadian Utilization - 2000

Figure 2



US Production and Use - 2000

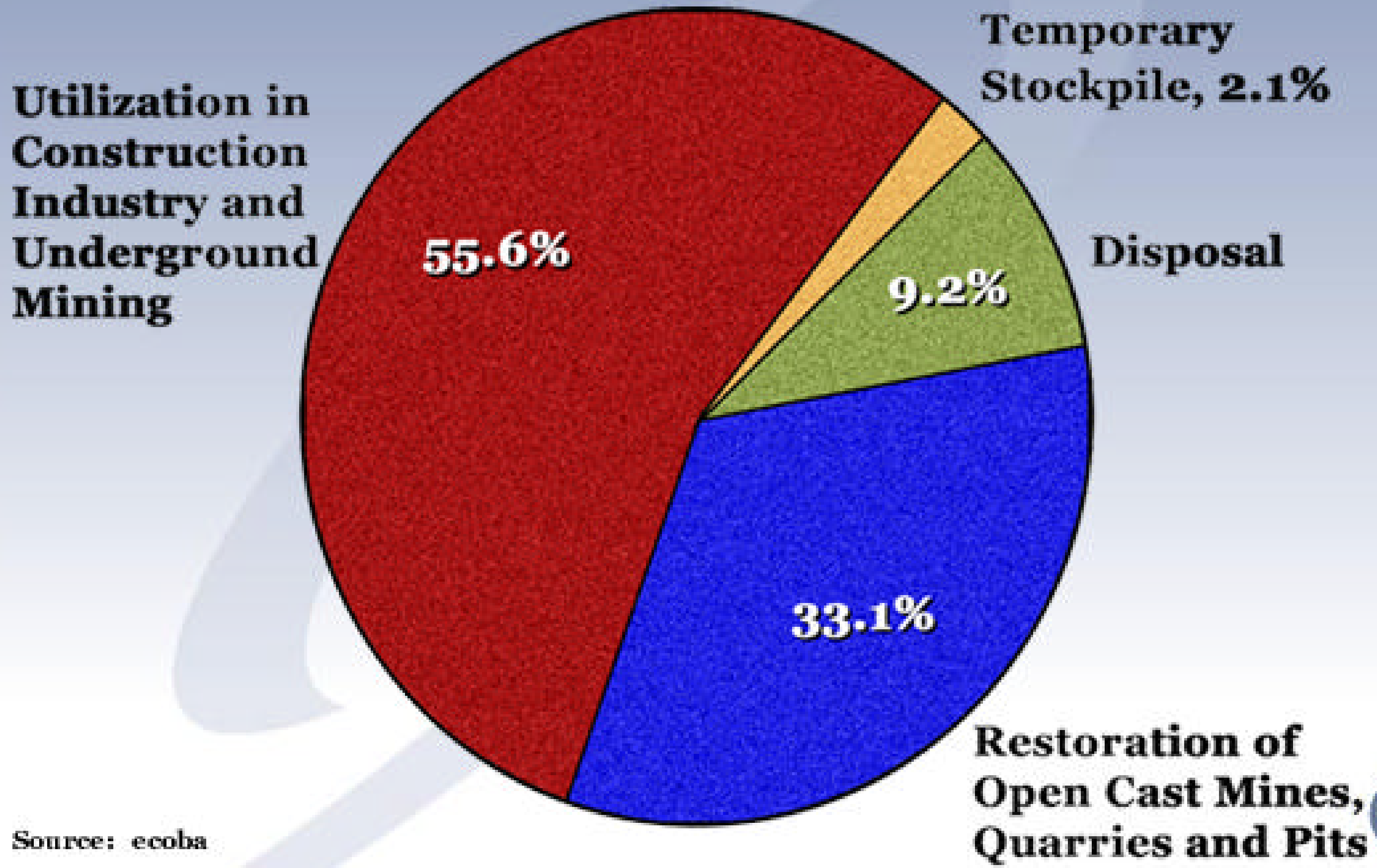
Figure 3



CIRCA

European (ECOBA) Utilization - 2000

Figure 4



Source: ecoba

Contributing to clean air and reducing CO_2

The Industry reduces CO_2 emissions and contributes to cleaner air by the following actions:

- **Promoting the use of coal combustion products (CCP) such as fly ash to replace a portion of cement in concrete.**
- **Reduces the production of CO_2 with the replacement of Portland Cement in the Ready Mixed Concrete.**
- **Allows the increased use of concrete in the construction of Public roadways, reducing road friction and saving fuel by up to 10 % and lowering emissions.**

Public Policy Interests

We can provide solutions and expertise

Environmental Policy

- clean air
- climate change
- contaminated sites
- regulatory harmonization

Infrastructure Renewal

- rebuilding/expanding highways
- trade corridors
- sewage treatment
- water treatment
- housing

CIRCA

Environmental Solutions

Concrete highways contribute to clean air and reduce CO_2

- **NRCan is investing $3.5 million over five years to promote concrete highways as a means of reducing GHG emissions**
- **Year-round average of up to 11% less fuel required for trucks (NRC)**
- **Lower maintenance requirements reduce congestion and idling traffic, resulting in cleaner air**

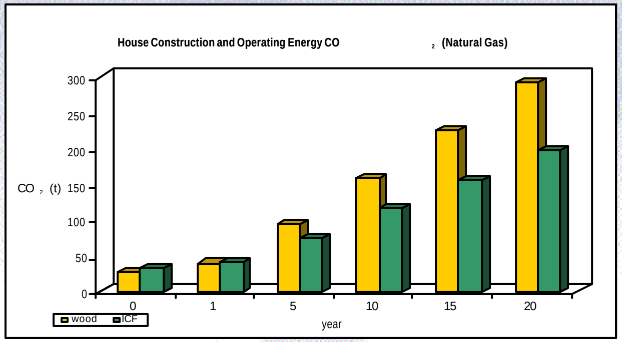
CIRCA

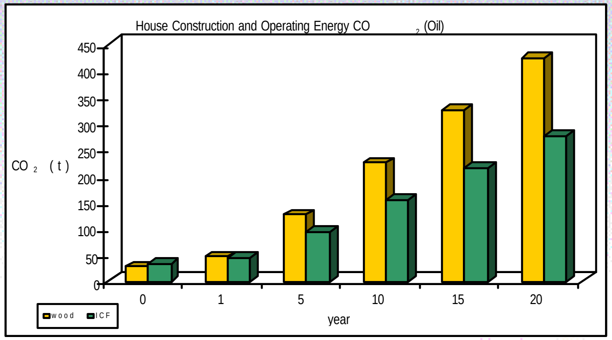
Environmental Solutions

Building with concrete contributes to clean air and reduces CO_2

Insulating Concrete Form (ICF) Houses:

- **use 40% less operating energy than traditional wood framed homes**
- **12% market share in 2010 would reduce GHG by 6.8 Mt - 10.9 Mt**

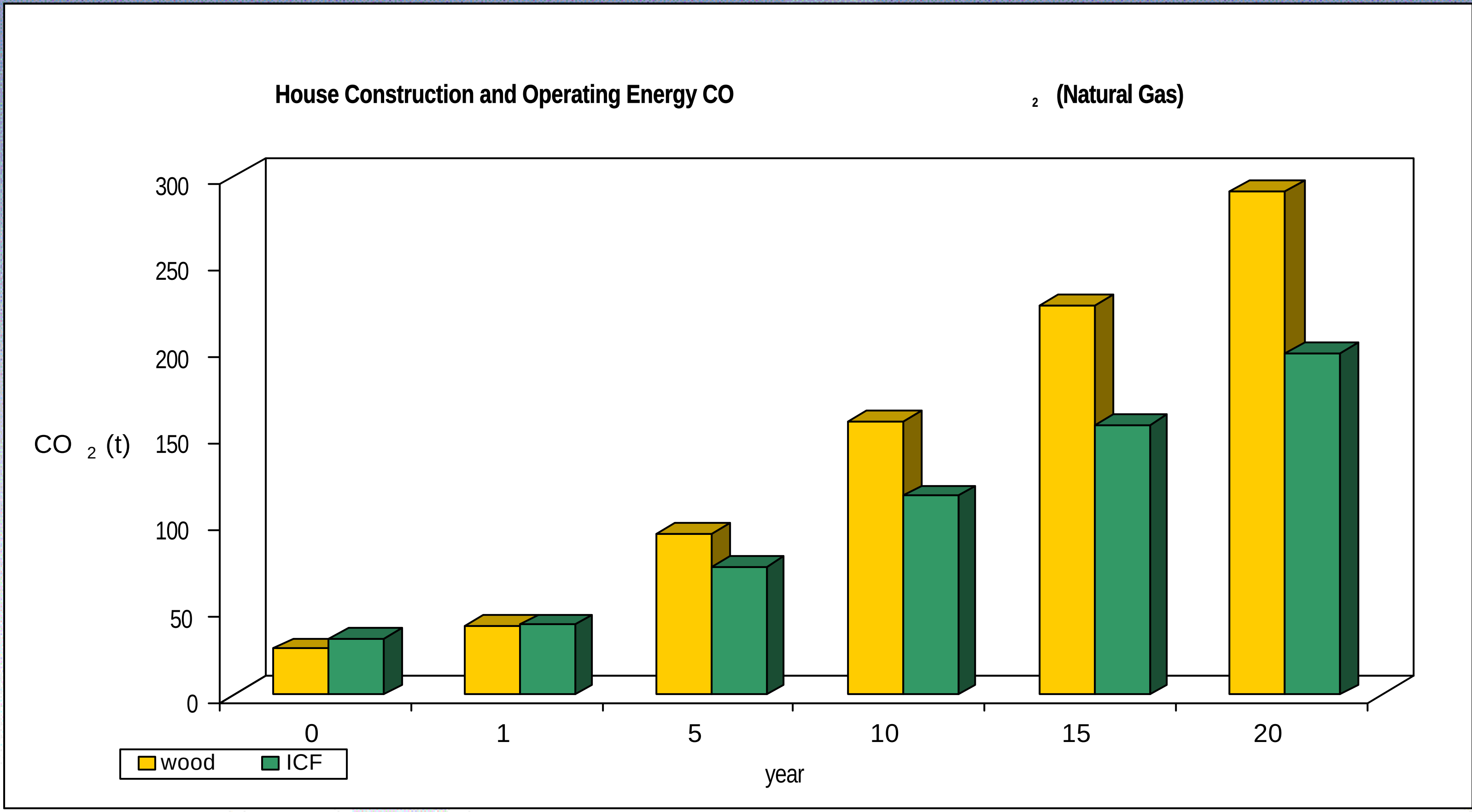




Residential GHG 7% of Canadian total

Environmental Solutions

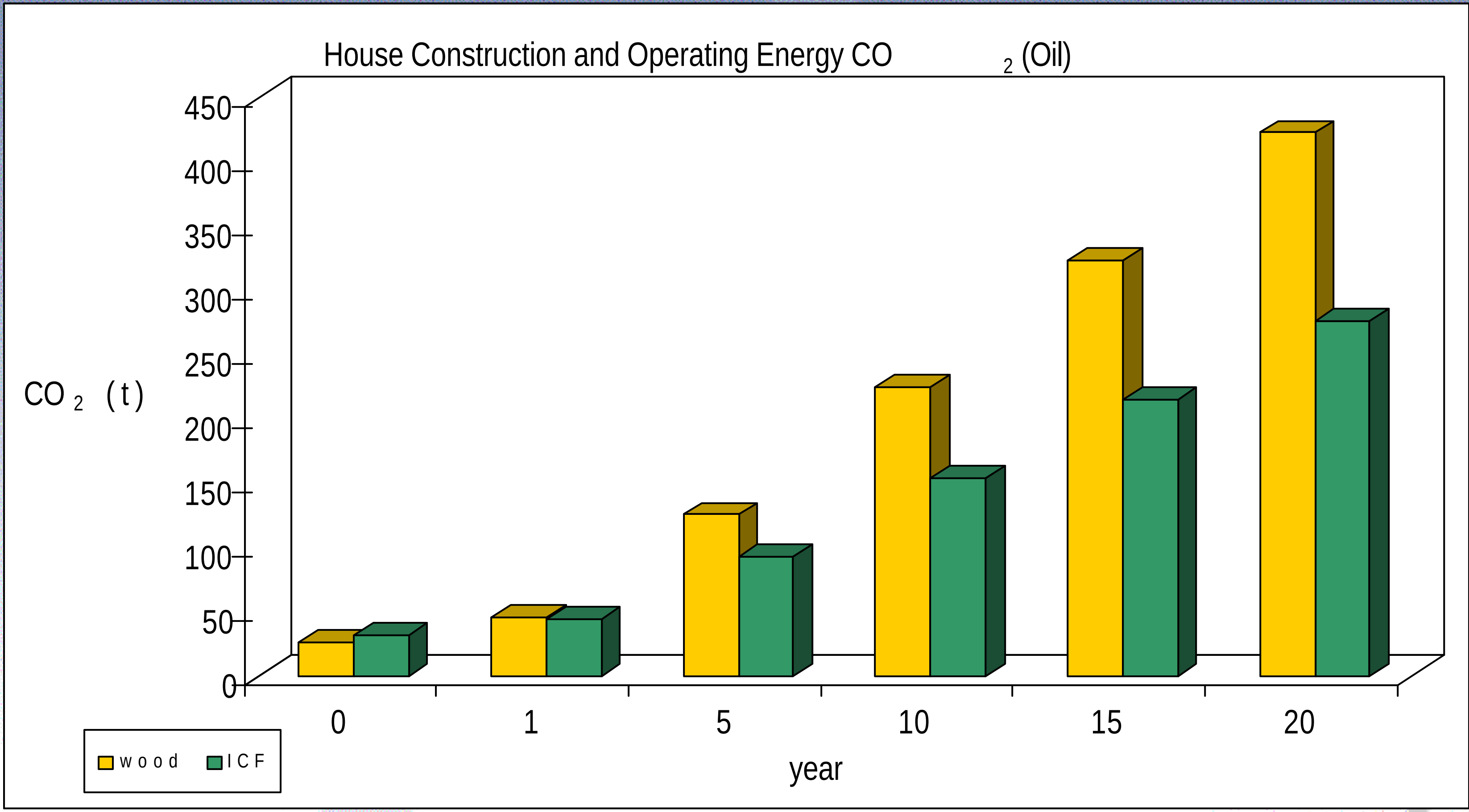
Building with concrete contributes to clean air and reduces CO_2



Residential GHG 7% of Canadian total

Environmental Solutions

Building with concrete contributes to clean air and reduces CO_2



Residential GHG 7% of Canadian total

Environmental Solutions

Contaminated site remediation, hazardous waste disposal, and agricultural waste management

- **Fly Ash in Cement-based solidification and stabilization (S/S) treatment can treat industrial wastes for disposal AND restore contaminated lands to productive use**
- **Fly Ash in Concrete manure storage facilities improves prevention of leaching**
- **Industry is working with strategic partners to develop an energy smart solution to agricultural waste management**

Solidification:

- **Refers to changes in the physical properties of a waste. The desired changes usually include increased compressive strength, decreased permeability, and encapsulation of hazardous constituents.**

Stabilization:

- **Refers to chemical changes of the hazardous constituents in a waste. The desired changes include converting constituents into a less soluble, less toxic form.**

Working with Government

CIRCA is committed to providing cleaner air for Canadians

- **CIRCA advises Government on how to reduce air pollutants:**

1. Public Works has included the use of CCP in its latest Canada Wide Standard

2. Environment Canada is receiving input on the characterization of CCP produced in Canada and its use, providing useful data for understanding the environmental impact when deciding positions in legislation and international agreements.

CIRCA

Advocacy Issues

The CCP Industry would like the Government to:

- **adopt a "credit-for-early-action" plan with respect to CO_2 reductions**
- **recognize the industry's support of using CCP by offering CO_2 credits ** Coal Combustion Products***
- **consider concrete, cement's end product, when measuring $C0_2$**

CIRCA

Infrastructure Renewal

An investment in prosperity

- The CCP Industry applauds the Government on its $ 2 Billion infrastructure program announced in Budget 2000.
- The CCP Industry supports the call from the provinces and various sectors of the economy for more investment in infrastructure.
- The CCP Industry is ready to add value to the government’s initiatives by providing expertise, cost-effective and environmentally sustainable solutions.

CIRCA

Concrete Highways

Provide good value for taxpayers' dollars

- **Last twice as long as asphalt, therefore better value over life of highway**
- **Require lower maintenance: reduces delays to users**
- **Improved safety from better visibility at night and superior traction**
- **Contribute to economic efficiency and productivity through reduced fuel consumption for heavy trucks and no spring weight restrictions**

Concrete Highways

The ideal solution for trade corridors

Government should consider concrete as the paving material of choice for trade corridors because:

- **Concrete highways absorb the weight of freight trucks without deforming and therefore last longer**
- **Heavy trucks require up to 11% less fuel when driving on concrete, a savings for the economy and the environment**
- **Almost 1/3 of all GHG comes from truck and car emissions**

CIRCA

Environmental Dividends
Manure Waste Treatment

- **Growing public awareness and concern over state of infrastructure that maintains water supply**
- **Increased concern as farms get bigger and livestock production increases - increased manure waste**
- **Industry investing in R&D on concrete in waste management solutions like biogas technology**

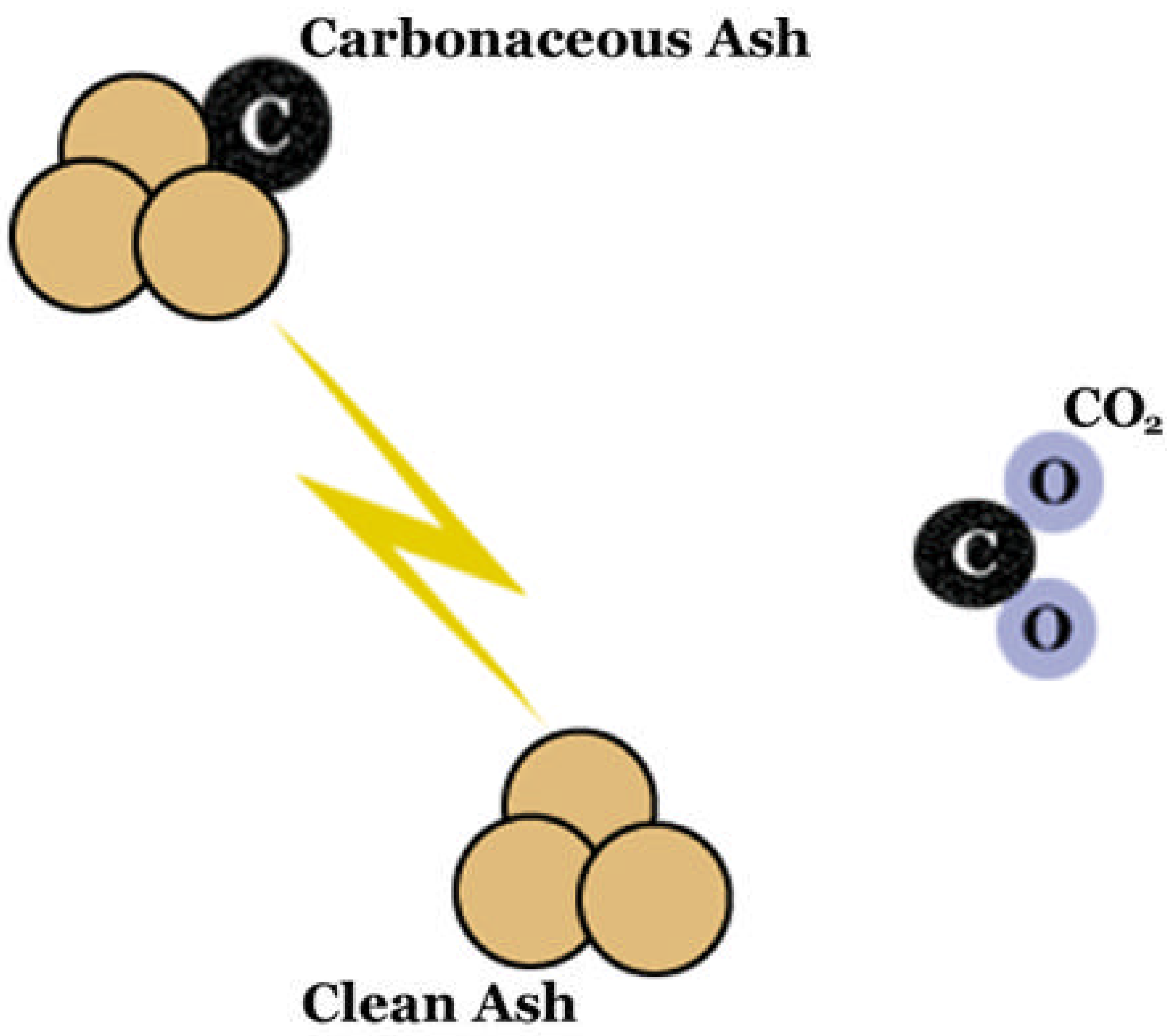
CIRCA

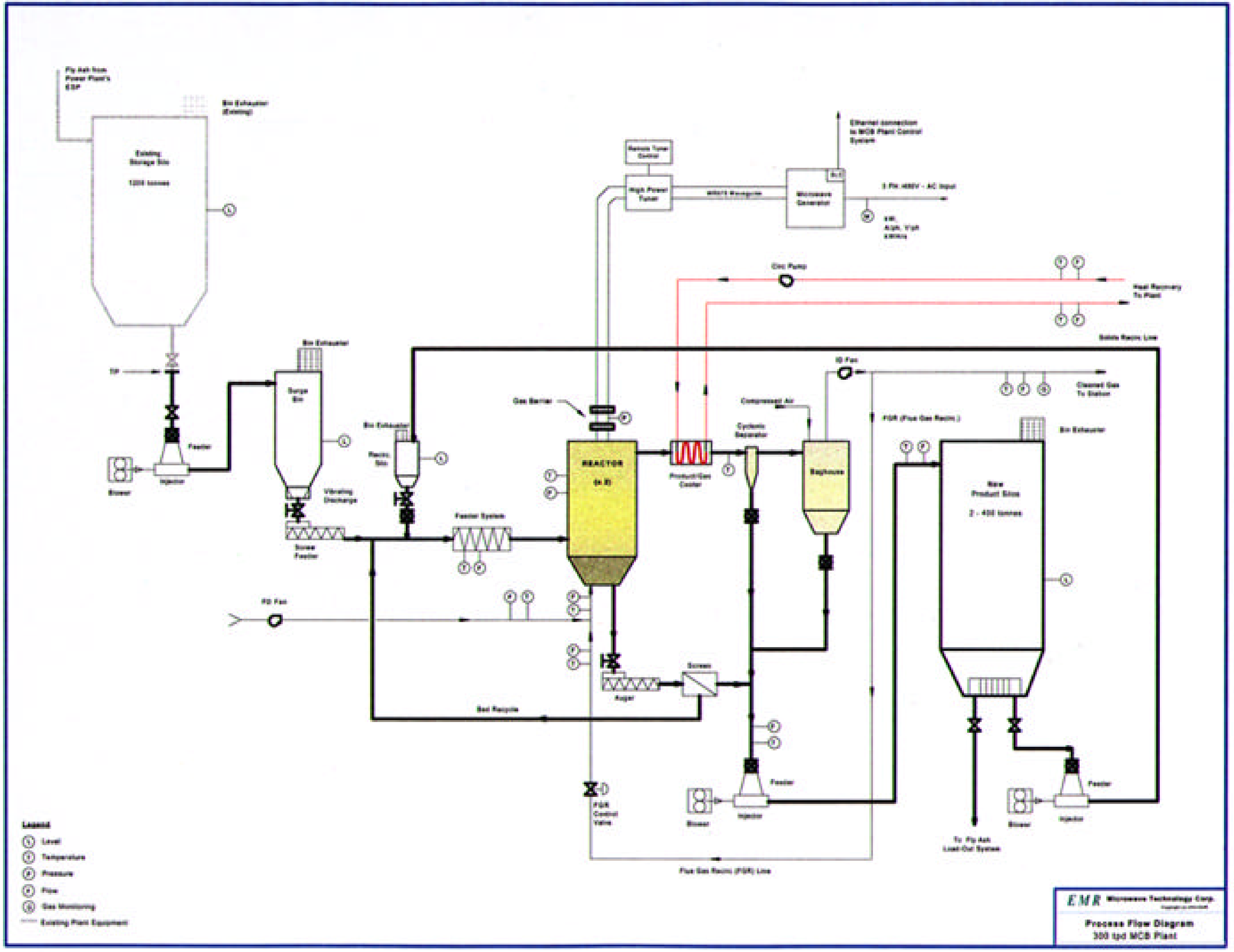
Cementing Canada's Future

The CCP Industry has the expertise, the product and the capacity to help build a superior infrastructure for generations to come.

CIRCA

Microwave Combustion




Existing Storage Silo
Bin Exhauster
Surge Bin
Vibrating Discharge
Screw Feeder
Feeder System
Feeder
Injector
Blower
FD Fan
Gas Barrier
REACTOR
High Power Tuner
Microwave Generator
Circ Pump
Heat Recovery To Plant
Solids Recirc Line
ID Fan
Cleaned Gas To Station
Compressed Air
Cyclonic Separator
Product/Gas Cooler
Baghouse
Raw Product Silos
Bed Recycle
Auger
Screen
FGR Control Valve
Flue Gas Recirc (FGR) Line
To Fly Ash Load-Out System
Legend
Level
Temperature
Pressure
Flow
Gas Monitoring
Existing Plant Equipment
EMR Microwave Technology Corp.
Process Flow Diagram
300 tpd MCB Plant


EMR Pilot Plant
Commissioned Q4, 1997

Historical US Production and Utilization Profile

Table 1

(Thousand metric tons)

	1996	1997	1998	1999	2000
Fly ash:					
Production	53,900	54,700	57,200	56,900	57,100
Use	14,700	17,500	19,200	18,900	17,600
Percent use	27.50	32.10	33.60	33.20	30.90
Bottom ash:					
Production	14,600	15,400	15,200	15,300	15,400
Use	4,430	4,600	4,760	4,930	4,460
Percent use	30.40	30.20	31.30	32.10	29.00
Boiler slag:					
Production	2,360	2,490	2,710	2,620	2,430
Use	2,170	2,340	2,170	2,150	2,120
Percent use	92.30	94.10	80.10	81.80	87.00
FGD material: 1/					
Production	21,700	22,800	22,700	22,300	23,300
Use	1,500	1,980	2,260	4,030	4,380
Percent use	6.96	8.67	10.00	18.10	18.80
Total CCP's:					
Production	92,400	95,400	97,800	97,100	98,200
Use	22,800	26,500	28,400	30,000	28,600
Percent use	24.90	27.80	29.00	30.80	29.10

1/ FGD, flue gas desulfurization.

Source: American Coal Ash Association.

Canadian Fly Ash Production and Use

Table 2

	Fly Ash	Bottom Ash	FGD Gypsum	Other 3/	Total CCPs
Production:					
Produced	5030	1558	421	128	7137
Disposed/stored	3985	1472	0	124	5582
Removed from disposal	0	138	0	0	138
Use (domestic):					
Cement	491	143	0	0	634
Concrete/grout	400	0	0	0	400
Mining applications	136	0	0	0	136
Roadbase/subbase	20	49	0	0	69
Wallboard	0	0	570	0	570
Other 4/	46	5	0	0	51
Total use	1094	196	570	0	1860
Individual use percentage	22%	13%	135%	0%	n.a.
Cumulative use percentage	22%	20%	27%	26%	26%

Notes:

1/ Production of coal combustion products (CCPs) may include both dry and ponded categories.

2/ Use (domestic) includes amounts imported (assumed to be HS codes 2621.00 relating to fly ash, and HS 2520.10 relating to gypsum.

3/ Cfb (circulating fluidized bed) fly ash and bottom ash.

4/ Includes waste stabilization and specialty uses such as mineral filler and flowable fill.

n.a., not applicable; FGD, is synthetic gypsum derived from flue-gas desulphurization.

Sources:

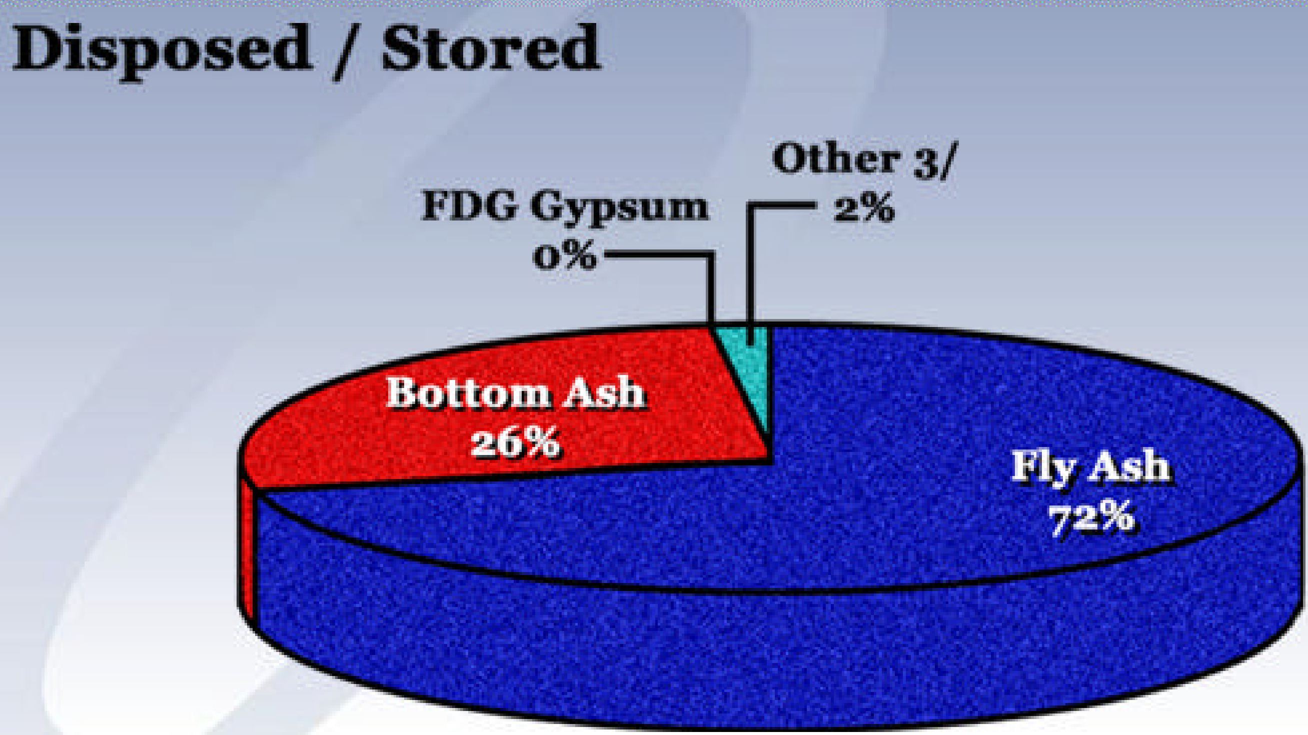
Compiled by Natural Resources Canada (Minerals and Metals Sector), in cooperation with the Canadian Electricity Association.

Date: November 5/01

CIRCA

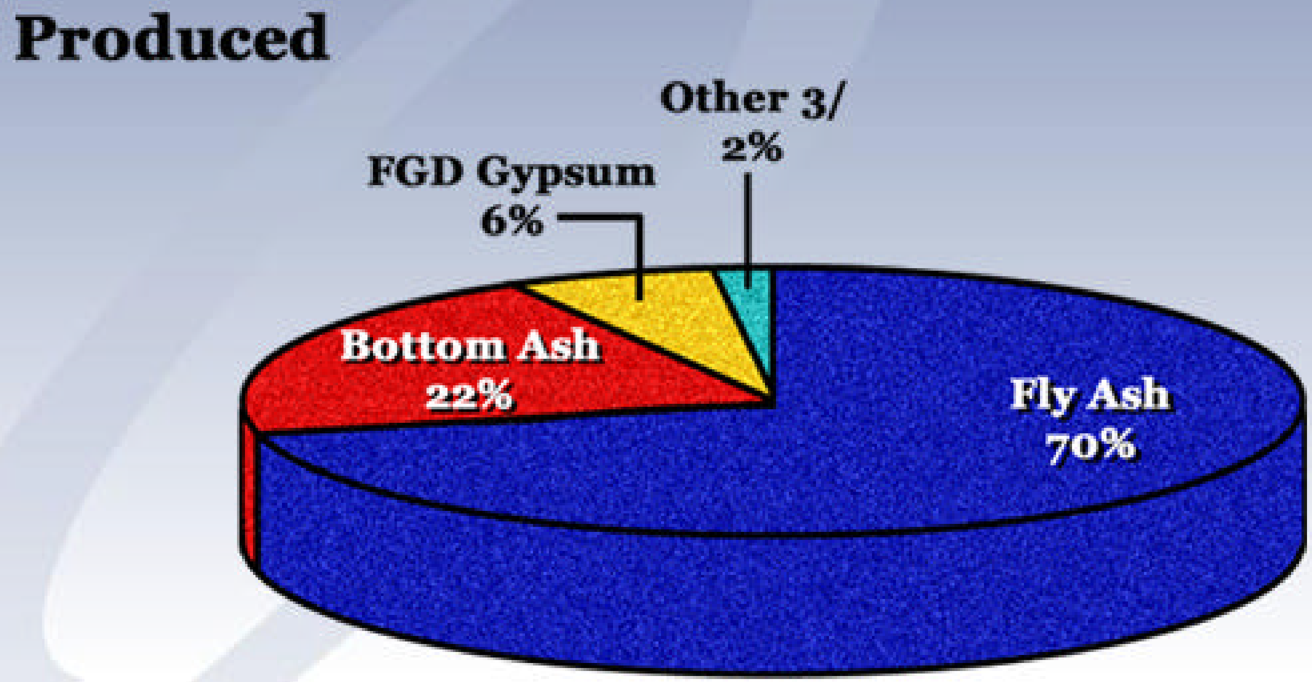
Canadian Production - 2000

Figure 1



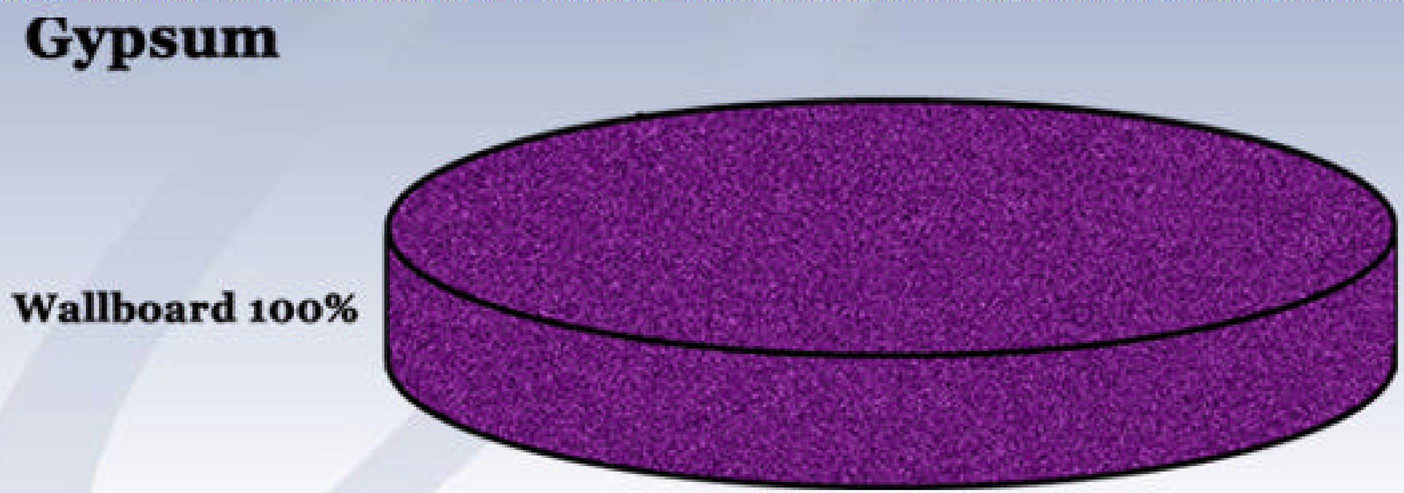
Canadian Production - 2000

Figure 1



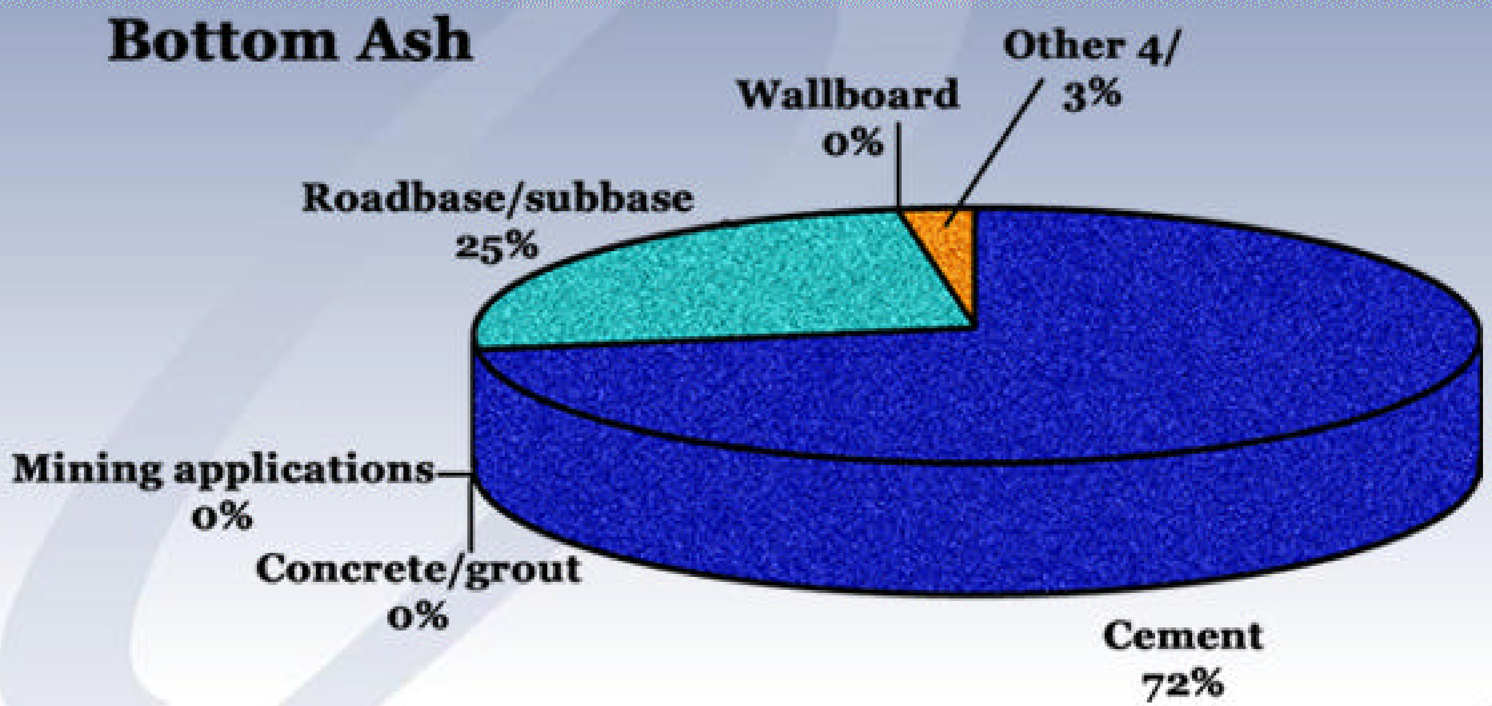
Canadian Utilization - 2000

Figure 2



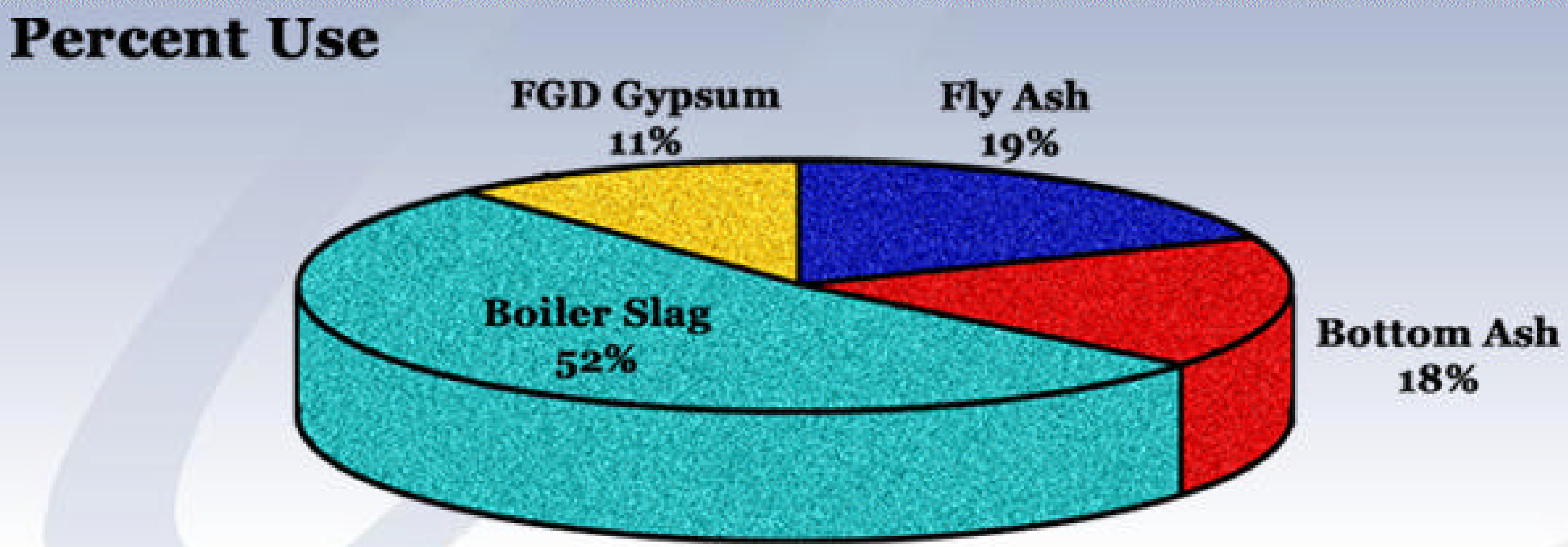
Canadian Utilization - 2000

Figure 2



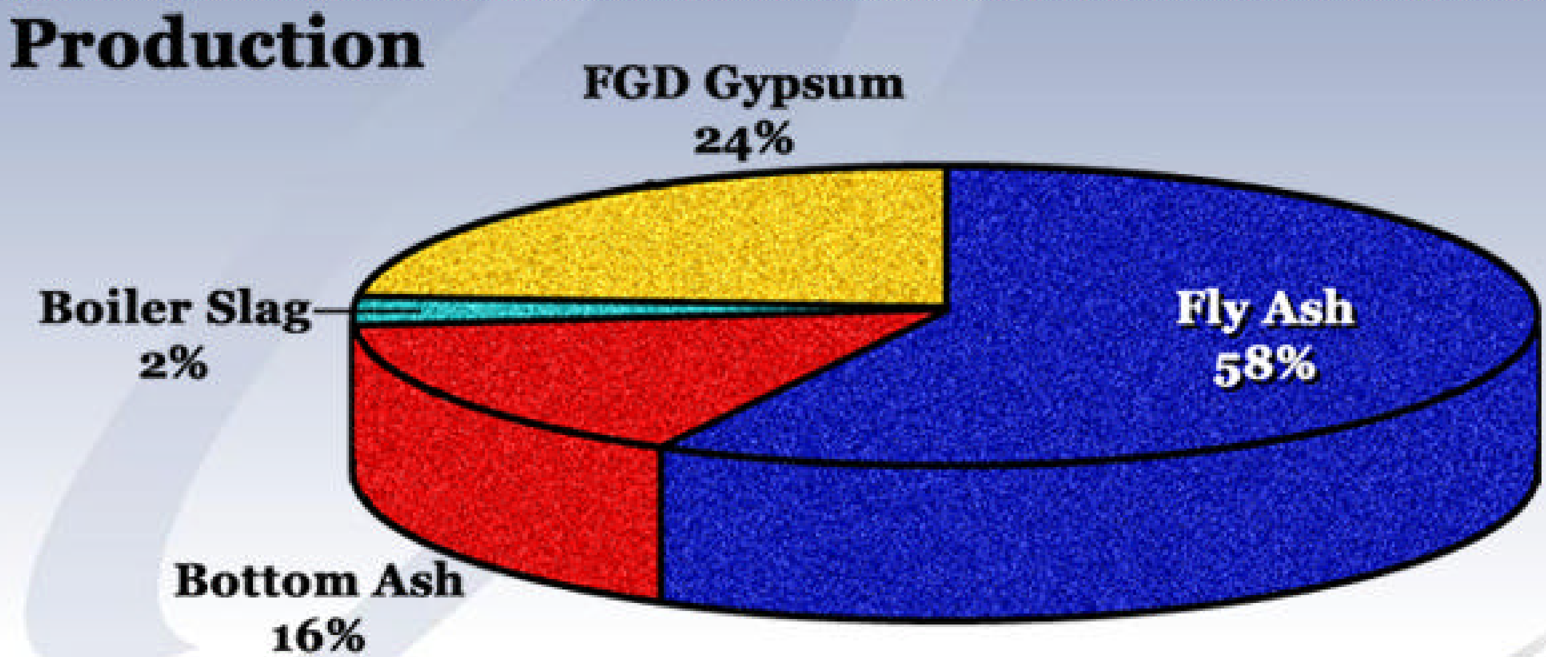
US Production and Use - 2000

Figure 3



US Production and Use - 2000

Figure 3



CIRCA